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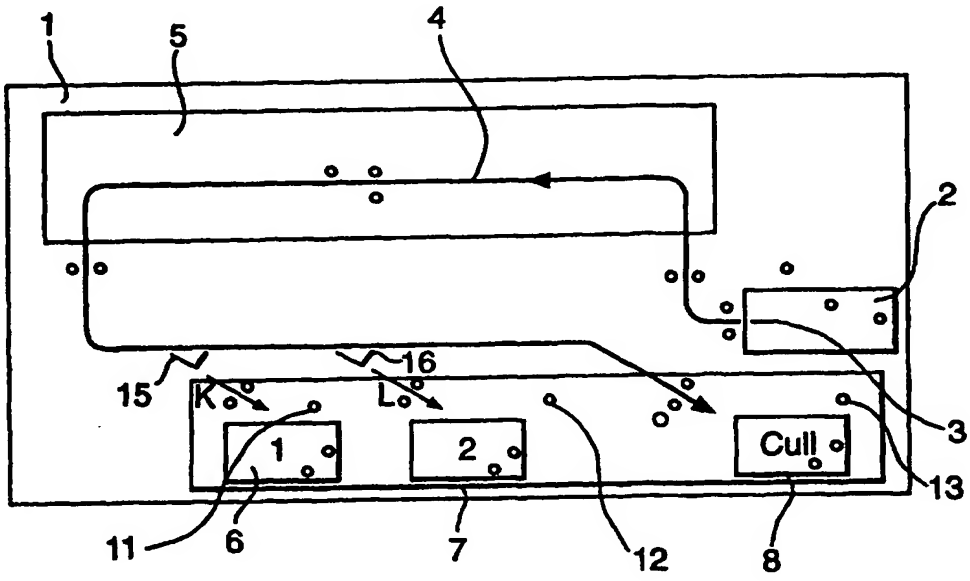
(54) Title: DOCUMENT SORTER AND METHOD



(57) Abstract: A document sorter comprises an input station (2) for receiving a stack of documents to be sorted; a plurality of output stations (6, 7, 8); a transport system (3) for transporting documents from the input station to the output stations; and a discriminator (5) for detecting a characteristic of each document fed by the transport system. A controller (14) is responsive to the discriminator (5) to control the transport system (3) to feed each discriminated document to the one of the output stations allocated to receive documents with the detected characteristic. The controller (14) is adapted to allocate output stations (6-8) for receiving documents having respective characteristics during the sorting operation.

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DOCUMENT SORTER AND METHOD

The invention relates to a document sorter and a method for sorting documents, for example documents of value such as banknotes. However, the invention is applicable to the sorting of any type of document having a characteristic which can be detected such as size, thickness, pattern and the like.

Such sorters are used for sorting and counting sheet material such as banknotes or other security documents of the type in which batches of at least two types or denominations of note, identifiable from each other by machine readable properties or characteristics, are to be sorted from each other. In general, these currency processing machines comprise an input station for receiving a stack of documents to be sorted; a plurality of output stations; a transport system for transporting documents from the input station to the output stations; a discriminator for detecting a characteristic of each document fed by the transport system; and a controller responsive to the discriminator to control the transport system to feed each discriminated document to the one of the output stations allocated to receive documents with the detected characteristic.

Such equipment is available in the prior art, these equipment include, for example, simple two pocket machines, such as the De La Rue 2800 note counter, for recognising and counting a single denomination of currency, unrecognised sheets being transported to one of the stacking stations while recognised sheets are transported to the other stacking station. Three pocket machines are known for condition sorting, with recognition or authentication for a single denomination of currency in which unrecognised sheets are transported to one of the stacking stations, recognised sheets of acceptable condition are sent to a second stacking station or pocket, and the other recognisable sheets sent to the third

stacking station or pocket. Finally, multi-pocket machines are known for generally processing inputs of mixed denomination currency or less uninterrupted processing of batches of single denomination currency.

In these known multi-pocket machines, the operator typically allocates output stations to the particular note types or denominations they are to receive and the more note types or denominations which are to be handled, the more pockets need to be provided. In the smaller machines, the pockets are pre-allocated on manufacture, typically one pocket being allocated to receive notes of the type to be counted and the other pocket to receive any other notes.

There is a need to reduce the size of these machines while increasing their handling capabilities.

In accordance with a first aspect of the present invention, a document sorter comprises an input station for receiving a stack of documents to be sorted; a plurality of output stations; a transport system for transporting documents from the input station to the output stations; a discriminator for detecting a characteristic of each document fed by the transport system; and a controller responsive to the discriminator to control the transport system to feed each discriminated document to the one of the output stations allocated to receive documents with the detected characteristic and is characterised in that the controller is adapted to allocate output stations for receiving documents having respective characteristics during the sorting operation.

In accordance with a second aspect of the present invention, a method of sorting documents comprises transporting documents individually from an input station to one of a plurality of output stations, the output station being selected in accordance with a detected characteristic of each transported document and is characterised in that the output stations are allocated to receive documents having respective characteristics during the sorting operation.

We have recognised that in typical sorting operations, the documents will be presented in stacks divided into batches of documents of the same type. For example, in a retail situation, the retailer will pre-sort currencies in a till but he wishes to be able to count the currencies and also detect any mis-sorted notes. He will therefore extract each batch of pre-sorted notes and put them together in a stack forming a "rainbow" arrangement which is then placed in the input station. This pre-batching property is utilized in the present invention enabling output stations to be allocated dynamically during the sorting operation. Thus, initially, an output station will be allocated to documents of the first type transported (first denomination) while another output station is allocated to receive documents of a second type or denomination. Subsequently, after the first output station has been emptied by the operator, it can be reused for further documents of either the same or a different denomination. In this way, the number of output stations required is significantly reduced over the multi-pocket sorters of the prior art leading to a much more flexible and compact machine.

It will be appreciated in particular that the number of output stations available can be smaller than the number of characteristics used to select output stations, for example smaller than the number of denominations which the sorter is capable of sorting.

The sorter and method can be used in a variety of different modes. In some cases, they can be used for batching in which a predetermined number of sheets is fed to an output station whereupon no further sheets are fed to that output station until the fed stack has been removed. In other modes, a total count of sheets of different characteristics can be determined, sheets of a particular characteristic being fed to an output station until that output station is full whereupon sheets of that characteristic may be allocated to a new output station

without the need to stop the machine while the first output station is emptied, or alternatively the machine can stop to enable a full output station to be emptied whereupon the machine is restarted and feeding continues.

The invention is also able to handle special header documents which are often inserted into stacks of banknotes to indicate information such as origin and the like. In these cases, the controller is preferably adapted to respond to the detection of a header document to allocate documents having the same characteristic as that of the document following the header document to a currently empty output station.

If there is no currently empty output station, the transport system would halt while the operator emptied one of the output stations.

The characteristics which are detected may be denominations in the case of banknotes and this could be determined from the size of the banknote or part or all of the pattern or other feature carried on the banknote in a conventional manner. Sorting according to other characteristics such as condition, thickness and the like is also envisaged.

Some examples of document sorters and methods according to the invention will now be described with reference to the accompanying drawings, in which:-

Figure 1 shows a general front view of a three pocket sorter/counting machine;

Figure 2 is a schematic view of the sheet transport arrangement which exists in the three pocket sorter/ counting machine shown in Figure 1;

Figure 3 is a block diagram of the control components of the machine shown in Figure 1;

Figures 4A and 4B illustrate different contents of a look-up table;

Figure 5 is a flow diagram illustrating operation of the machine shown in Figure 1; and

Figure 6 is a perspective view of a two pocket sheet sorter.

As can be seen in Figures 1 and 2, the machine 1 comprises a sheet input station or hopper 2 to hold a bundle of sheets positioned in the input station by the machine operator. A sheet feed arrangement (shown schematically) 3 feeds sheets one at a time from the bundle of sheets into a sheet transport system 4 to transport the individual sheets through a detector area 5 to one of a number of stacking pockets or output stations 6,7,8. Sheets are directed to the pockets 6,7 by diverting arrangements 15,16 respectively which are operated by a machine processor or controller 14 (Figure 3) in accordance with its programmed process control instructions which utilise at least one detected characteristic of each sheet to determine the destination of that sheet. Sheets not diverted by diverting arrangements 15,16 are fed to the pocket 8. Typically the pocket 8 is used as a cull pocket. The input station 2 is designed to enable additional bundles of sheets for processing to be added to the station as the sheets at the feed arrangement position 3 are moved into the transport system 4.

Associated with each of the stacking pockets 6,7,8 are respective indicators 11,12,13 which in these examples are audible or visual indicators but can be any known means available to alert the operator to remove the stack of sheets from the associated pocket, which also operate on instructions provided by the machine processor 14 in accordance with the programmed process control instructions.

Other indicating means include the use of stacking pockets which automatically move out from the machine when the stacker has been determined full in order that the operator can remove the stacked contents, and the automatic ejection, transporting or dropping of a stack of sheets after the stack has been automatically banded.

Figure 3 illustrates the control components of the machine in more detail. The main controller 14, typically in the form of a microprocessor, is connected to receive signals from the detector area 5 as sheets are passed through the area by the transport system 4. Any known detector can be incorporated in the detector area. For example, a pattern recognition detector may be used as will be described below in more detail. However, other types of detector such as a size detector and the like could also be used. The controller 14 is also connected to the diverters 15,16; to the main transport motor 17 which drives the transport system 4; to a memory 18; to a number of pocket sensors 19 which sense the content of each pocket 6-8; and a number of displays including the indicators 11-13.

The controller 14 also maintains a count defining the number of documents in each pocket, the respective counts being indicated at 20-22.

The operation of the novel machine and process will now be described.

A bundle of banknotes comprising a number (at least two) of denominations of banknotes arranged in a number of denomination batches in the bundle at least equal to the number of denominations contained within the bundle and positioned sequentially or randomly within the bundle, is positioned within the input station 2. The bundle may contain denomination batches received by the processing organisation from a number of sources. If it is required that the machine maintains, for example for verification or reconciliation purposes, a count of the number of notes in each of the different note denominations the machine identifies for each source, then machine identifiable/ readable header or trailer (or both header and trailer) documents of known types will be inserted into the bundle in required positions prior to loading the bundle into the machine feeding position.

The operator then selects the machine operating mode, in this case identified as the "dynamic pocket allocation"

mode and operates a feed start control which is received by the controller 14. The controller 14 activates the motor 17 and the feed arrangement 3 while all stacker counters are zeroed (step 60, Figure 5).

The first sheet is picked by the sheet feeder arrangement 3. The sensor in the detector area 5 monitors the appropriate characteristic, in this case pattern on the sheet, and the monitored signals are passed to the controller 14. The controller 14 then attempts to identify the sheet by reference to the sensed pattern and to a number of previously defined reference patterns stored in the memory 18 (step 30, Figure 5).

The controller 14, having identified the type of sheet, in this case denomination since banknotes are being fed, decides whether this denomination is "new" in the sense that so far neither of the output pockets 6,7 has been allocated to banknotes of that denomination (step 31). In the case of the first note, this will always be a new note and so an output station has to be allocated. The controller 14 checks to see whether either of the output stations 6,7 (step 32) is unused and if it is, allocates that output station to the sensed denomination (step 33). If there are no output stations available then the machine transport must be stopped (step 34), the controller halting the transport motor 17. The operator will then need to remove the notes from one of the pockets so that this can be allocated to the sensed denomination.

Following allocation of the new pocket in step 33, the "empty pocket" indicator 11,12 for the other pocket is activated (step 65) and this remains active (step 66) until the pocket is emptied. The pocket counter is then zeroed (step 67).

The identified note is then transported to the allocated output station (step 35), for example in this case output station 6, and one of the counts, for example the count 20 is incremented either by one (step 36) so as to provide a running indication of the number notes of the

"first" denomination which have been counted or is incremented by the value of the denomination so as to provide a running indication of the value of the "first" denomination notes which have been counted. Since this total may include notes previously counted and removed a second count 22 is maintained of the total current contents of the output station 6 (step 61).

The controller then checks to see whether the output station 6 is full or contains a batch of notes having a predetermined batch quantity (step 37) if operating in a batch mode. If the controller 14 determines the stacker 6 is full or contains the predetermined batch quantity, it allocates an empty output station, in this case output station 7 to the next note to be recognised at step 62 and activates an appropriate one of the indicators 11,13, in this case 11, to prompt the user to empty the output station (step 38) which is full or contains the predetermined batch size, in this case 6. The actuated indicator remains active (step 63) until the notes are removed from the associated output station. The controller then zeros the counter associated with the emptied output (step 64), in this case counter 22 for output stacker 6.

In the event of the next note recognised at 31 being of the "first" denomination after the allocation of output station 7, count 20 continues to be incremented either by one (step 36) to keep a running indication of the number of the "first" denomination notes which have been counted or is incremented by the value of the denomination so as to provide a running indication of the number of notes of the "first" denomination which have been counted, whilst a further count 23 may be maintained of the total current contents of the output station 6 (step 61).

In the event the controller determines at step 37 that the allocated output station is not full or the pre-set batch count has not been reached, the process returns to step 30.

When the next "new" denomination is sensed in step 31, the controller 14 checks to determine which of the output stations is empty and allocates it to receive the notes of this denomination. This output stacker could be either output stacker 6 or 7 depending on how many notes of the original "first" denomination were processed before the "new" denomination was sensed. Either way, the controller 14 activates the relevant indicator 11 or 12 to prompt the user to empty the output station containing the "first" denomination notes.

Assuming, for example, the controller allocates output station 7 to the "new" denomination the count 21 corresponding to the "new" denomination is incremented either by one (step 36) to keep a running indication of the number of the "new" denomination notes which have been counted or is incremented by the value of the denomination so as to provide a running indication of the number of notes of the "new" denomination which have been counted. Since this total may include notes previously counted and removed, the further count 23 maintains the total current contents of the output station 7 (step 61).

Pocket 8 is used as a cull station to receive all the "notes" not recognised by the influencing sensors such as the denomination sensor at step 30, although it could be allocated to a further denomination if required.

If the operator has failed to empty a pocket so that there is no free pocket, the machine transport will stop.

The allocation of pockets to sheet type at this stage is summarized in Figure 5A. In this example, the first denomination "DENOM1" was stored in pocket 6, the second denomination "DENOM2" was stored in pocket 7 and pocket 8 was used as a cull pocket.

During further processing of banknotes, a third denomination may be sensed in the detection area 5. At that time, the pocket 6, is empty so that pocket can be allocated to the new denomination. If the next denomination to be sensed is the first denomination

"DENOM1" then this cannot be allocated to the pocket 6 since that pocket contains notes of the third denomination. However, the pocket 7 should have been emptied of the second denomination and so is free to be allocated to the first denomination. At this stage, the allocation of pockets is as shown in Figure 5B.

Rogue notes will be transported to the pocket 8.

In an alternative process, headers, as previously described, are incorporated into the stack inserted into the input station 2. In this case, the first sheet detected within the detector area 5 will be a header. Any code on the header will be read by an at least one code reader (not shown) of known type also positioned within the detector area. The header is transported to one of the stacking pockets, preferably for example the pocket 8, predesignated for receiving all header documents and banknotes not recognised by the banknote pattern detector or authentication detectors. The first fed banknote to be recognised by the pattern recognition detector following the header is directed to one of the empty pockets, for example pocket 6 as before. If the next and following fed banknotes are then recognised to be of the same denomination as the first note, these are also fed to the same stacking pocket 6. If a new header is recognised, the banknote following that header is recognised and that note and all the following notes recognised to be of that denomination are directed to empty pocket 7 whilst the controller 14 indicates to the operator by activating the indicator 11 that he should remove the banknotes stacked in the pocket 6. If the controller 14 recognises that the stacking position 6 is full or has reached a predetermined batch count number, the following notes of the first denomination are diverted to empty stacking position or pocket 7 whilst the controller 14 indicates to the operator by activating the indicator 11 that he should remove the banknotes stacked in 6. If the recognition detector recognises a second denomination of currency, that sheet

and all following sheets recognised to be of the second denomination are directed to empty stacking position 7 and the controller 14 indicates to the operator by activating the indicator 11 that he should remove the banknotes stacked in 6. As previously indicated, a second header is directed to stacking position 8.

If a third header is recognised, the banknote following that header is recognised and that note and all the following notes recognised to be of that denomination are directed to the emptied stacker position 6 whilst the controller 14 indicates to the operator by activating the indicating means 12 that he should remove the banknotes stacked in 7. If the process recognises that the stacking position 7 is full or has reached a predetermined batch count number, the following notes of the denomination being directed to emptied stacker 7 are diverted to stacking position 6 whilst the controller 14 indicates to the operator by activating the indicator 12 that he should remove the banknotes stacked in 7. If the recognition detector recognises a third denomination of currency, or a note of the first recognised denomination, that sheet and all following sheets recognised to be of the third (or first) denomination are directed to emptied stacking position 6 and the controller 14 indicates to the operator by activating the indicator 12 that he should remove the banknotes stacked in 7. As previously indicated, the third header is directed to stacking position 8. And so the process continues.

The particular advantage with this process using headers is that it provides the operator with the means to physically reconcile the various stacks of processed notes of each denomination with the expected total value of the currency supplied from each source.

As can be understood, the sequence of continually putting documents for recognition, sorting and counting into the feeding station 2, the recognition of each of the transported documents by the machine's detectors to

determine the destination of the documents and the repeated emptying of the stacking pockets 6-8 when the machine process control instructs and indicates such pocket emptying should occur, provides means for continuously sorting any number of banknote denominations and/or currencies with the minimum of machine stoppages.

Furthermore, although the sequencing described above discusses the use of header or trailer sheets to enable the machine to identify sources from which the notes being processed have arrived, if such information is not required, these documents are not used. Likewise, other means, such as the operator keying in the required information when prompted by the machine having seen an uncoded header or trailer, may be used to identify the batch sources.

This process allows stacks of predetermined numbers of notes of the same denomination to be completed more often within the stacking pockets.

The embodiment described above is based on a three pocket machine. The invention is applicable, however, to the use of more than three pockets such as five pockets or to a machine having just two pockets as shown in Figure 6. In this machine, which is similar to the De La Rue 2800 counting machine, sheets are initially stacked in an input hopper 50 and transported by a transport system (not shown) to one of two output stacking positions 51,52. The operation of this machine will not be described in detail since it will be readily apparent to a person of ordinary skill in the art that it is a simple modification of the machine described in Figures 1-5. In this case, however, when a rogue note is detected, the machine will stop, this rogue note being transported to one of the output pockets so that it can be removed.

If the machine shown in Figure 6 is to be used for sorting a stack which includes headers then typically one pocket 51,52 will be allocated to receive headers while the other pocket will be allocated to receive sheets of the

denomination immediately following the header. If a new denomination is detected then the machine will stop to allow the stacked banknotes and/or headers to be removed following which an empty one of the output stations 51,52 will be allocated to the new denomination.

In applying the processes described above to two pocket banknote sorters of the type shown by Figure 6, alternative arrangements exist for processing involving the use of headers/trailers for batch identification. Where headers/trailers are not used the described techniques apply.

As mentioned previously, with these alternative processes it is understood the sequence of continually putting documents for recognition, sorting and counting into the feeding station (or input station), the recognition of each of the transported documents by the machine's detectors to determine the destination of the documents and the repeated emptying of the stacking pockets when the machine process control instructs and indicates such pocket emptying should occur, provides means for dynamically sorting and or batching of any number of banknote denominations and/or currencies with the minimum of machine stoppages.

The processing described above forms part of a note counting process which provides the facility to output to a display, printer or screen the banknote counts associated with each of the denomination and/or batches of denominations processed through the transport system 4. For example, where headers are utilised, data about the origin of the batch, such as a bank branch sort code, can be read either directly from code on the headers or by association with code on the headers, to provide reconciliation information to the machine operator. Even without using headers or trailers, the number of banknotes transported between each change of denomination is determinable and the count of each batch of notes sent to each of the stacking positions is determinable.

The innovative processes described herein are applicable to equipment for feeding or transporting sheets in either the direction of the short (Figure 6) or the long (Figures 1 and 2) dimensions of the sheets.

In some implementations, the operator may be able to increment the counts 20,21 manually if he is able to recognise one or more of the notes which are being fed to the cull pocket 8. These culled notes would then be added to the appropriate stack. Alternatively, the number or value of the culled notes could be entered into a separate memory, the appropriate values from that separate memory and the count 20,21 for corresponding note values then being added upon an operator instruction.

CLAIMS

1. A document sorter comprising an input station for receiving a stack of documents to be sorted; a plurality of output stations; a transport system for transporting documents from the input station to the output stations; a discriminator for detecting a characteristic of each document fed by the transport system; and a controller responsive to the discriminator to control the transport system to feed each discriminated document to the one of the output stations allocated to receive documents with the detected characteristic, characterised in that the controller is adapted to allocate output stations for receiving documents having respective characteristics during the sorting operation.

2. A sorter according to claim 1, further comprising an output station content counter associated with each output station for monitoring the content of the output station and for indicating if the documents in the output station satisfy a predetermined condition.

3. A sorter according to claim 2, wherein each monitor comprises a counter.

4. A sorter according to claim 2, wherein each monitor comprises a full condition detector.

5. A sorter according to any of claims 2 to 4, wherein the controller is responsive to the output station content monitors to provide an indication to the user when the predetermined condition is satisfied.

6. A sorter according to claim 5, wherein the predetermined condition is satisfied when a predetermined number of documents has been received in the output station.

7. A sorter according to any of the preceding claims, wherein the controller is adapted only to allocate an output station to receive documents having a particular characteristic if the output station is currently empty.

8. A sorter according to any of the preceding claims, wherein the controller is adapted to respond to the detection of a document with a different characteristic from the preceding document to allocate an output station for documents of that different characteristic from currently empty output stations.

9. A sorter according to any of the preceding claims, wherein the controller is adapted to respond to the detection of a header document to allocate documents having the same characteristic as that of the document following the header document to a currently empty output station.

10. A sorter according to any of the preceding claims, wherein the controller is adapted to indicate to an operator that an output station is to be emptied when it allocates a new output station to receive documents.

11. A sorter according to any of the preceding claims, wherein the documents comprise banknotes, the characteristics comprising denominations.

12. A method of sorting documents, the method comprising transporting documents individually from an input station to one of a plurality of output stations, the output station being selected in accordance with a detected characteristic of each transported document characterised in that the output stations are allocated to receive documents having respective characteristics during the sorting operation.

13. A method according to claim 12, wherein upon detection of a document with a characteristic different from the preceding document, the method further comprises allocating a currently empty output station to receive documents of that characteristic.

14. A method according to claim 12 or claim 13, wherein upon detection of a header document, the method further comprises allocating a currently empty output station to receive documents having the characteristic of the document following the header.

15. A method according to any of claims 12 to 14, further comprising maintaining a count of the number of documents of each characteristic.

16. A method according to any of claims 12 to 14, further comprising providing an indication when the number of documents in an output station satisfies a predetermined condition.

17. A method according to claim 16, wherein the predetermined condition is satisfied when the output station is full or a predetermined number of documents have been received.

18. A method according to any of claims 12 to 17, wherein the documents are transported to two or three output stations.

19. A method according to any of claims 12 to 18, wherein the number of output stations is smaller than the number of characteristics used to select output stations.

20. A method according to any of claims 12 to 19, wherein the documents comprise banknotes, the characteristics comprising denominations.

Fig.1.

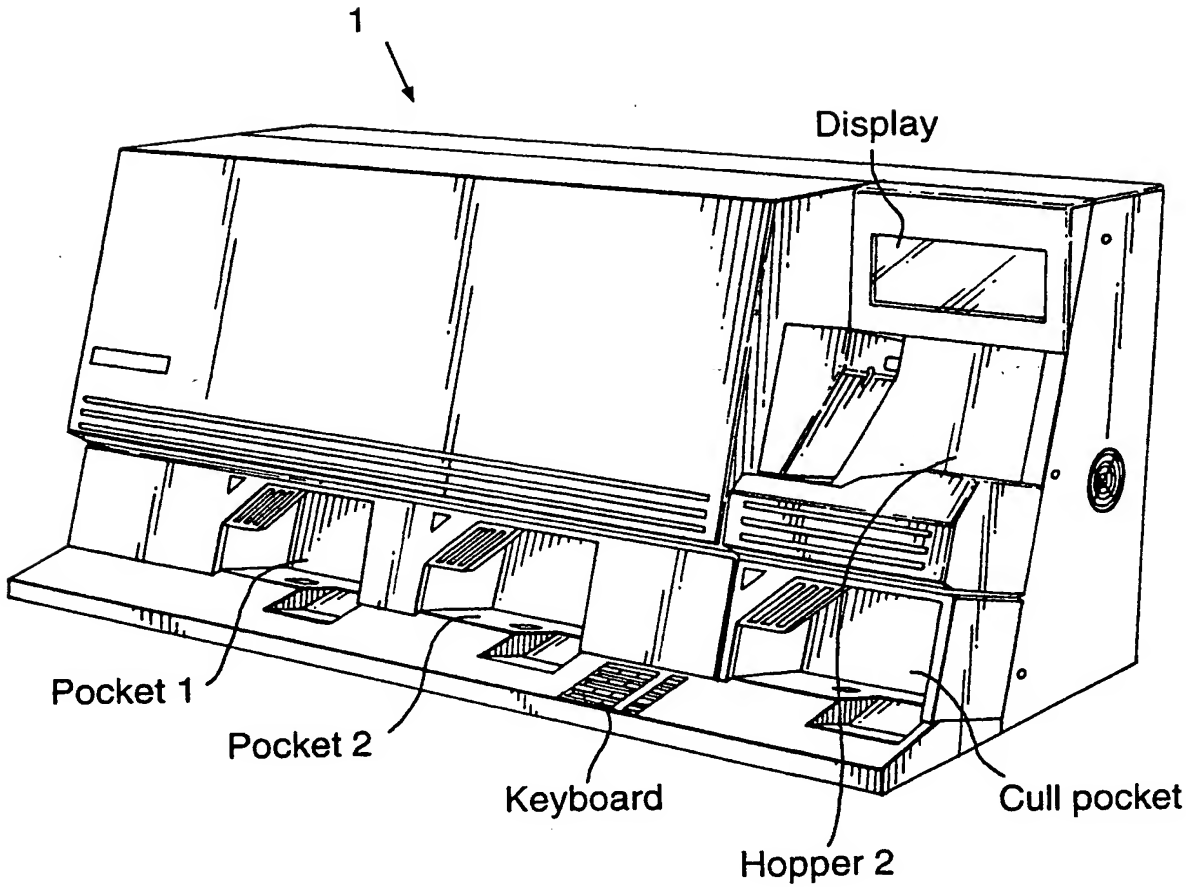


Fig.2.

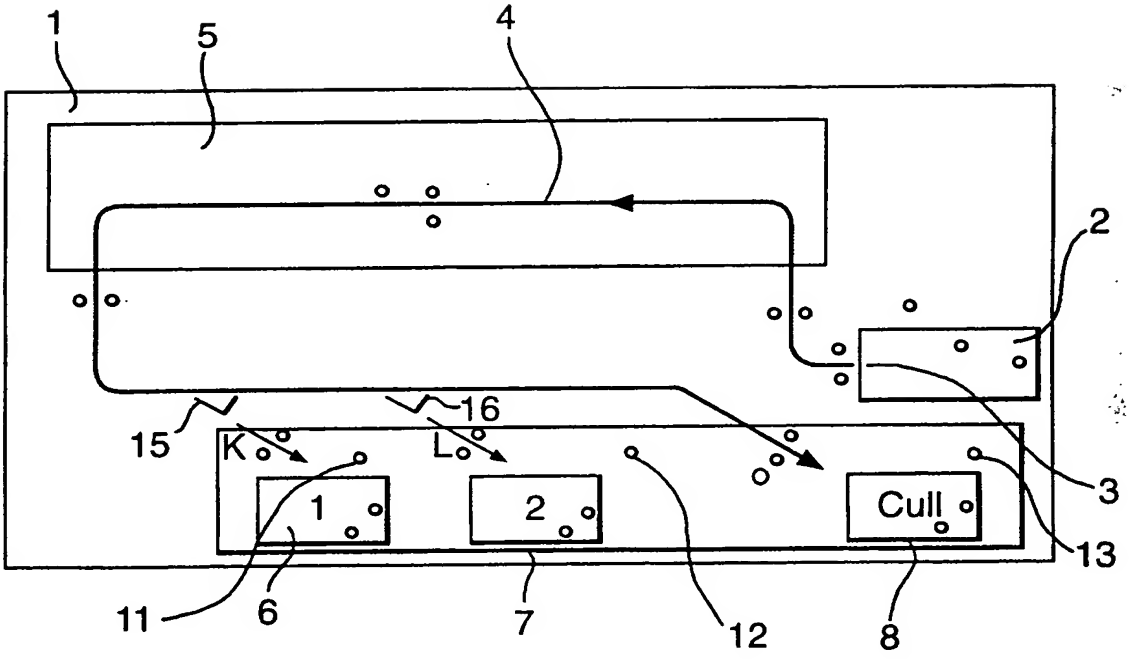


Fig.3.

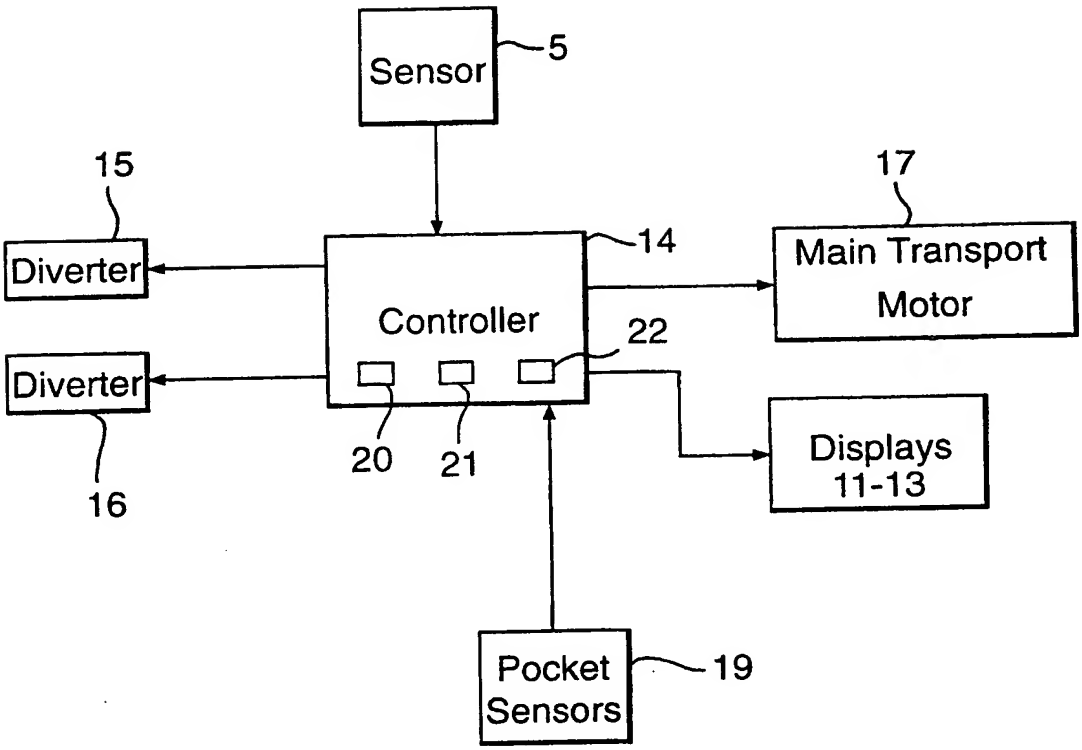


Fig.4.

Denom 1	pocket 6	denom 3	pocket 6
Denom 2	pocket 7	denom 1	pocket 7
Cull	pocket 8	cull	pocket 8
(A)		(B)	

Fig.5.

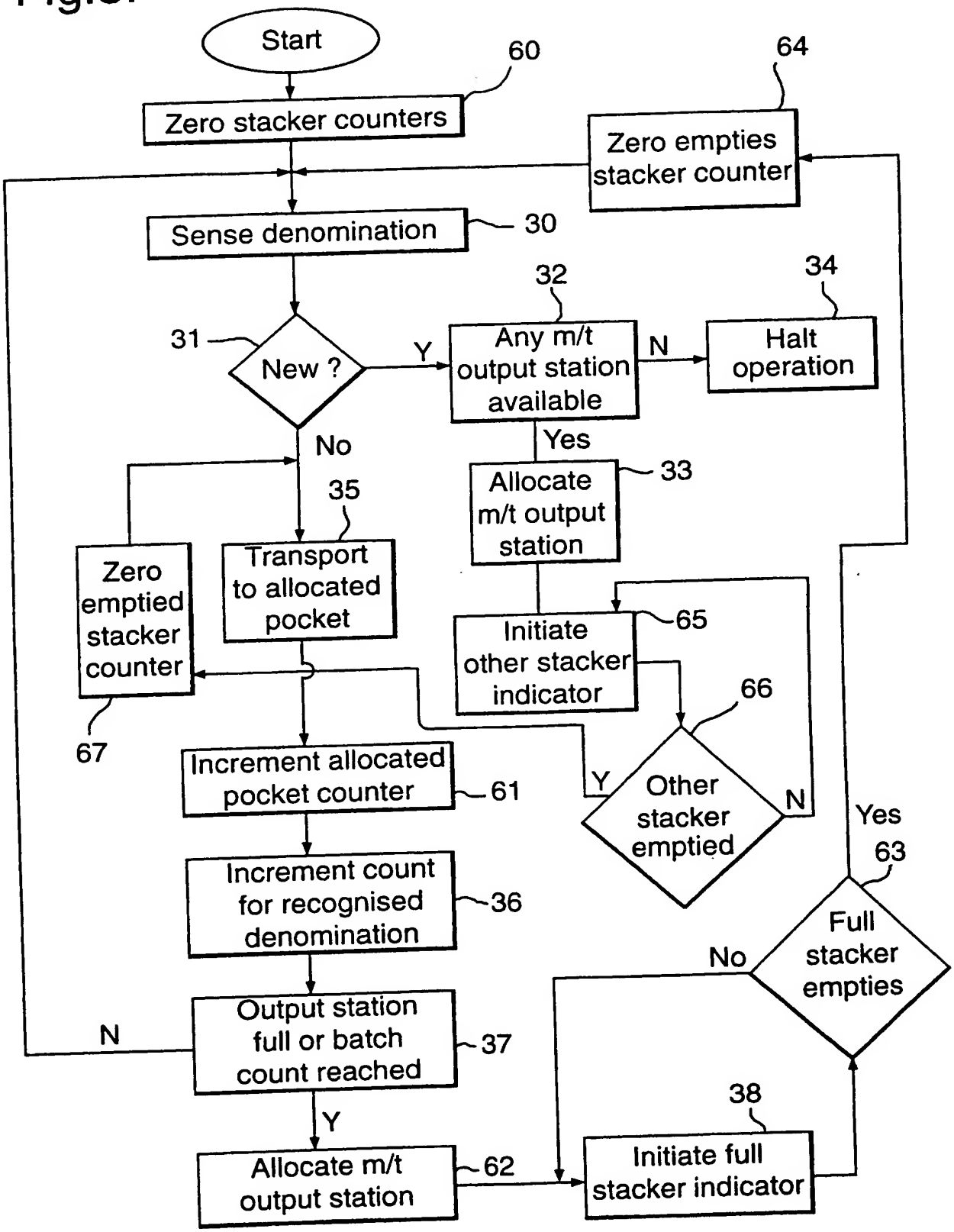
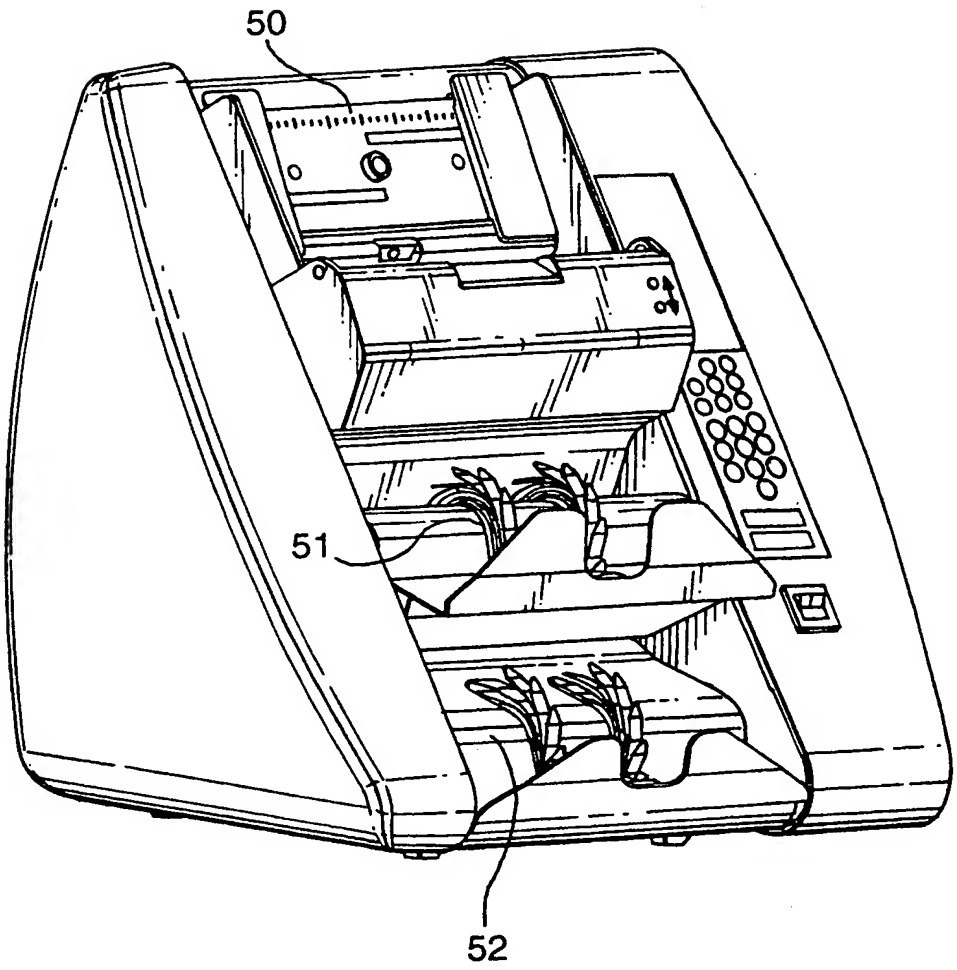

Start
60
Zero stacker counters
64
Zero empties stacker counter
Sense denomination
30
32
34
31
New ?
Y
Any m/t output station available
N
Halt operation
No
Yes
35
Allocate m/t output station
33
Zero emptied stacker counter
Transport to allocated pocket
Initiate other stacker indicator
65
66
67
Increment allocated pocket counter
61
Y
Other stacker emptied
N
Yes
63
Increment count for recognised denomination
36
No
Full stacker empties
Output station full or batch count reached
37
N
Y
38
Allocate m/t output station
62
Initiate full stacker indicator

Fig.6.



INTERNATIONAL SEARCH REPORT

Inte .ional Application No
PCT/GB 01/00214

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B65H39/10 G07D9/00 G07D7/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B65H G07D G07F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 952 556 A (CUMMINS ALLISON CORP) 27 October 1999 (1999-10-27) paragraphs '0013!,'0044!,'0045!,'0114!-'0165!; figures 1,2,12-14	1-8, 10-13, 15-20
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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10 May 2001	18/05/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040. Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Thibaut, E

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INTERNATIONAL SEARCH REPORT

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